DOCUMENT RESUME

ED 171 518 SE 026 951

AUTHOR Lindvall, C. Mauritz; Ibarra, Cheryl Gibbons
TITLE The Relationship of Mode of Presentation and of School/Community Differences to the Ability of Kindergarten Children to Comprehend Simple Story Problems.
SPONS AGENCY National Inst. of Education (DHEW), Washington, D.C.; Pittsburgh Univ., Pa. Learning Research and Development Center.
PUB DATE 79
NOTE 13p.; Paper presented at the annual meeting of the American Educational Research Association (San Francisco, California, April 8-12, 1979); Tables marginally legible

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Comprehension; *Educational Research; Elementary Education; *Elementary School Mathematics; *Instruction; *Kindergarten; *Problem Solving; Rural Urban Differences; Teaching Techniques

ABSTRACT

The extent to which kirdergarten children are able to solve simple quantitative problems merely through the application of counting procedures, before they receive formal instruction in any basic arithmetic operations, is investigated. The study indicates that most kindergarten children can comprehend simple story problems of the type used in typical classroom explanations of the meaning of addition and subtraction sentences. However, it also suggests that it is important that the presentation of such stories should be accompanied by a maximum use of the demonstration of the actions described in the stories. (MP)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

ED171514

AERA Session 8.06

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
C. Mauritz Lindvall
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

The Relationship of Mode of Presentation and of School/Community Differences to the Ability of Kindergarten Children to Comprehend Simple Story Problems

C. Mauritz Lindvall

Cheryl Gibbons Ibarra

Learning Research and Development Center

University of Pittsburgh

1979

The work reported herein was supported by the Learning Research and Development Center, supported in part by funds from the National Institute of Education (NIE), Department of Health, Education, and Welfare. The opinions expressed do not necessarily reflect the position or policy of NIE and no official endorsement should be inferred.

SE 026 951

The Relationship of Mode of Presentation and of School/ Community Differences to the Ability of Kindergarten Children to Comprehend Simple Story Problems

C. Mauritz Lindvall
Cheryl Gibbons Ibarra

University of Pittsburgh

The general purpose of this study was to investigate the extent to which kindergarten children are able to solve simple quantitative problems, merely through the application of counting procedures, before they receive formal instruction in any basic arithmetic operations. Specifically it provides data concerning (1) the extent to which a broadly representative sample of kindergarten pupils have this ability in dealing with each of six specific types of problems, (2) the extent to which this ability varies among children from different types of communities and (3) the extent to which the effect of different modes of problem presentation varies with community type.

Perspective

Earlier investigations by the writers (Lindvall and Ibarra, 1978) served to document the fact that many primary grade pupils have difficulty in explaining the meaning of simple addition and subtraction sentences. This was taken to be at least a partial explanation of why children at this level have difficulty in solving open sentences (Weaver, 1971, Grouws, 1972, Case, 1978). Since a typical procedure for introducting students to the symbolism used in

writing addition and subtraction sentences involves a description of some simple story (e.g., "Tom had 2 marbles. His brother gave him 3 more. How many did he have then?") and then the presentation of the addition sentence for the story, it would seem to be important to determine if such stories have any meaning for children. If such stories are not meaningful to a child then that child cannot be expected to grasp the meaning of the number sentence based on the story. Determining what kinds of simple stories pupils can comprehend before they have any formal instruction in addition and subtraction could provide useful insights as to why some pupils cannot later explain the meaning of number sentences.

Method

This study involved personal interviews with 113 kindergarten pupils. During each interview the student was presented with a total of 30 simple story problems and asked to provide an answer. The thirty stories involved six different problem types. These types can be described in terms of the number sentences that they might, in later instruction, be used to illustrate: (1) $a + b = \square$ (with a described transformation), (2) $a + b = \square$ (with a static condition described), (3) $a - b = \square$ (transformation), (4) $a + \square = c$ (transformation), (5) $a + \square = c$ (static), (6) $a - \square = c$ (transformation). Each type was presented under five different modes of presentation; (1) story only, (2) story, objects available to child, (3) story, examiner shows sets described, (4) story, pictures used to describe actions, (5) story, examiner shows sets and described actions. The row and column headings used in Tables 1 through 6 serve to show how these six variations in problem type and five variations in mode of presentation serve to structure the data analyzed in this study.

Numbers used in the stories were such that all sums, in both addition and subtraction problems were 7 or less, and all addends were greater than one. The addends and sums used with each of the thirty problem types were varied systematically so that this could not be a factor in causing differences in performance on the major factors investigated. The basic data used in analysis were the proportions of students solving each story type in each community.

Data for the study were obtained by interviewing kindergarten children in each of five different schools in varying community settings. The purpose in working in five different communities was not to determine the effect of any specific community type but rather to see if there was any overall difference associated with differences in community environment. The five different communities in which the schools were located were (1) inner-city, (2) residential suburb, (3) rural, (4) small industrial community, and (5) university lab school.

Results

Tables 1 through 6 summarize, for each school, the performance of the students on each story type under each of the modes of presentation. Since the measure of pupil performance for each cell in these tables was based on one story representing that particular story type and that specified mode of presentation, each pupil received either a score of 1 (pass) or a score of 0 (fail). The mean of such measure for any given cell, then, is both the mean score obtained by students in that school and the proportion of these students passing that item.

School/Community Differences. Table 7 presents the summary of the analysis of variance of the data present in Tables 1-6. This shows, first of all[1], that the difference among the school means (the overall means of

.395, .497, .560, .404, and .420 in Tables 1-5) is signifcant. This difference while statistically significant at the .05 level, is not very large in an absolute sense and is probably best interpreted as merely documenting the fact that there are differences among schools in certain basic abilities that the students have at the start of their schooling. Perhaps of more interest here is the fact that the school variable does not interact significantly with either of the major factors investigated in this study, that is, with mode of presentation or problem type. This suggests that there are no differences associated with type of school or community in terms of the mode of problem presentation that is most effective or in terms of the problem types that cause the most difficulty. Because of this lack of any significant interaction of school type with these two major factors, an examination of the differences associated with mode of presentation and with problem type can make use of the data pooled over the five schools as summarized in Table 6.

Mode of Presentation. The major question investigated in this study was the effect of mode of problem presentation on pupil ability to solve the stories. The means for the five variations in mode of presentation are presented in the bottom row of Table 6. Table 7 shows that the difference among these means is significant at the .001 level. As would be anticipated, the presentation of the story by merely reading it to the child with no type of manipulative objects available was the most difficult condition while a presentation involving the actual display of the sets and the transactions involved was easiest. The other three modes were somewhat intermediate in difficulty and fairly similar to one another in this respect.

Since the first order interaction of mode of presentation with problem type is significant, the interpretation of results with respect to effect of mode of presentation must take this into account. However, a study of the

proportions within the rows of Table 6 shows that "story only" results in a proportion that is rather consistently smaller than the proportions for other modes in a given row and that the proportions resulting from the fifth mode, "show actions," is consistently larger than the other proportions in that row.

Problem Type. Another major variable tested in the analyses of data for this study is problem type. The six problem types used, described above, are identified by the row headings shown in Tables 1 through 6. The results of the analysis of variance show that the main effect of this variable, as represented by the means in the right hand column of Table 6, is significant. An analysis of these results is described elsewhere (Ibarra and Lindvall, 1979) and is not a focus of the present paper.

Discussion

This study investigated the extent to which kindergarten pupils understand and are able to solve the simple types of story problems that teachers use in explaining the meaning of addition and subtraction sentences when such sentences are first introduced in school. The assumption is that if pupils cannot solve such stories by some simple counting process then they are not ready to comprehend the number sentences that can be used to represent the story. Results from this study show that a relatively small proportion of students (.389 and .478 for simple addition stories and .277 for all types of stories) are able to solve such stories if they only hear the story. However a much larger proportion of students (.761 and .779 for simple addition stories and .754 for all types of stories) are able to solve the story if it is acted out for them. This supports the importance of the rather typical practice of first grade teachers of using relatively complete demonstrations of a story when it is being used to illustrate a number sentences. However, it is also important to note that a substantial proportion of students (approximately .25) cannot solve these simple stories even when they are rather

fully acted out. This would seem to imply a need for some type of readiness program to get these pupils to the point where they can solve such stories before they are exposed to number sentences.

In a limited effort to determine the source of difficulty for students who could not solve the stories under any of the modes of presentation, three such students were interviewed and tested further. To study their comprehension of a story such as "Jim has 3 fish. Amy has 2 fish. How many fish do Jim and Amy have altogether?" they were asked to show what each sentence meant as it was read. In carrying out this test, a picture of a boy was placed on the table in front of the student with the explanation "this is Jim." Then a picture of a girl was placed alongside the other picture with the explanation "this is Amy." The students were then given the story, one sentence at a time, and asked to show what it said. When told "Jim has 3 fish," the students placed 3 blocks on Jim's picture. When told "Amy has 2 fish," they placed 2 blocks on Amy's picture. Also, when asked "How many fish do Jim and Amy have altogether?" They counted the total number and answered "5". Two of the three students interviewed were successful when given the story in this way. Evidently these students were better able to grasp the meaning of the story when the characters involved were made more real. We are currently investigating the meaning of this result.

Significance of the Study

This study indicates that most kindergarten children can comprehend simple story problems of the type used in typical classroom explanations of the meaning of addition and subtraction sentences. However, it also suggests that it is important that the presentation of such stories should be accompained by a maximum use of the demonstration of the actions described in a story.

It also indicates that as story types and the associated number sentences become more complex (e.g., missing addend sentences) teachers must be aware of the fact that a majority of the students may not even comprehend the very stories that are expected to clarify the meaning of the sentences. This suggests that teachers might well conduct some type of diagnosis of pupil ability to solve simple story problems of this type before formal instruction on addition and subtraction is started, identify those students who lack this ability, and provide further readiness activities for them.

Footnote

[1]The order (0) variable shown in Table 7 represents a test of the effect of a simple reversal in the order of presentation to the student of mode 3 and mode 4. This was found to be non-significant and is not discussed in this paper.

References

Case, R. Piaget and beyond: Toward a developmentally based theory and technology of instruction. In R. Glaser (Ed.), Advances in Instructional Psychology (Vol. 1). Hillsdale, New Jersey: Lawrence Erlbaum Associates, 1978.

Grouws, D. A. Open sentences: Some instructional considerations from research. The Arithmetic Teacher, 1972, 19(7), 595-599.

Ibarra, C. G., & Lindvall, C. M. An investigation of factors associated with children's comprehension of simple story problems involving addition and subtraction prior to formal instruction on these operations. Paper to be presented at the National Council of Teachers of Mathematics Meeting, Boston, Mass., 1979.

Lindvall, C. M. & Ibarra, C. G. An analysis of incorrect procedures used by primary grade pupils in solving open addition and subtraction sentences. Pittsburgh: University of Pittsburgh, Learning Research and Development Center, 1978.

Weaver, J. F. Some factors associated with pupil's performance levels on simple open addition and subtraction sentences. The Arithmetic Teacher, 1971, 18(7), 513-519.

Proportions of Students in Each Community Responding Correctly to

Each Story Type Under Each Mode of Presentation

Table 1. Inner City School (N=19)

Problem Type	Story Only	Obj. Avail.	Show Sets	Pict-ures	Show Act.	All Modes
a + b = □ Trans.	.316	.579	.684	.421	.737	.547
a + b = □ Static	.316	.737	.632	.579	.684	.590
a - b = □ Trans.	.316	.316	.316	.368	.947	.453
a + □ = c Trans.	.053	.053	.053	.105	.526	.158
a + □ = c Static	.053	.053	.105	.158	.579	.190
a - □ = c Trans.	.211	.421	.421	.211	.895	.432
All Probs.	.211	.360	.369	.307	.728	.395

Table 2. University Lab School (N=18)

Problem Type	Story Only	Obj. Avail.	Show Sets	Pict-ures	Show Act.	All Modes
a + b = □ Trans.	.333	.611	.667	.500	.833	.589
a + b = □ Static	.556	.611	.833	.611	.722	.667
a - b = □ Trans.	.167	.444	.444	.444	.889	.478
a + □ = c Trans.	.333	.278	.111	.556	.556	.367
a + □ = c Static	.111	.389	.111	.500	.722	.367
a - □ = c Trans.	.222	.611	.444	.389	.889	.511
All Probs.	.287	.491	.435	.500	.769	.497

Table 3. Suburban School (N=29)

Problem Type	Story Only	Obj. Avail.	Show Sets	Pict-ures	Show Act.	All Modes
a + b = □ Trans.	.448	.655	.793	.759	.897	.710
a + b = □ Static	.655	.690	.897	.897	.897	.807
a - b = □ Trans.	.414	.379	.448	.552	.931	.545
a + □ = c Trans.	.103	.345	.207	.448	.655	.352
a + □ = c Static	.103	.379	.207	.414	.655	.352
a - □ = c Trans.	.586	.655	.276	.621	.828	.593
All Probs.	.385	.517	.471	.615	.811	.560

Table 4. Rural School (N=18)

Problem Type	Story Only	Obj. Avail.	Show Sets	Pict-ures	Show Act.	All Modes
a + b = □ Trans.	.389	.389	.611	.556	.611	.511
a + b = □ Static	.389	.389	.778	.722	.778	.611
a - b = □ Trans.	.278	.278	.278	.278	1.00	.422
a + □ = c Trans.	.056	.167	.000	.222	.444	.178
a + □ = c Static	.167	.222	.167	.222	.556	.267
a - □ = c Trans.	.222	.500	.167	.389	.809	.433
All Probs.	.250	.324	.334	.398	.713	.404

Table 5. Industrial Community School (N=29)

Problem Type	Story Only	Obj. Avail.	Show Sets	Pict-ures	Show Act.	All Modes
a + b = □ Trans.	.414	.517	.621	.586	.690	.566
a + b = □ Static	.414	.552	.828	.621	.759	.635
a - b = □ Trans.	.172	.414	.276	.241	.966	.414
a + □ = c Trans.	.000	.034	.103	.310	.517	.193
a + □ = c Static	.138	.276	.069	.276	.724	.297
a - □ = c Trans.	.207	.517	.172	.448	.724	.414
All Probs.	.224	.385	.345	.414	.730	.420

Table 6. All Five Schools (N=113)

Problem Type	Story Only	Obj. Avail.	Show Sets	Pict-ures	Show Act.	All Modes
a + b = □ Trans.	.389	.538	.681	.584	.761	.595
a + b = □ Static	.478	.602	.805	.699	.779	.673
a - b = □ Trans.	.274	.372	.354	.381	.947	.466
a + □ = c Trans.	.097	.177	.106	.336	.549	.253
a + □ = c Static	.115	.274	.133	.319	.655	.299
a - □ = c Trans.	.310	.549	.283	.434	.832	.482
All Probs.	.277	.422	.394	.439	.754	.461

Table 7

Summary of the Four-Factor Analysis of Variance

Source of Variation	Degrees of Freedom	Mean Squares	F Value
Order, O	1	0.43151	0.32
School, Sc	4	3.85102	2.86*
O x Sc	4	1.89763	1.41
Error	103	1.34874	
Mode, M	4	20.40957	97.87**
M x O	4	0.30358	1.46
M x Sc	16	0.18232	0.87
M x O x Sc	16	0.32660	1.57
Error (M)	412	0.20854	
Problem complexity, P	5	13.68326	83.26**
P x O	5	0.10516	0.64
P x Sc	20	0.13601	0.83
P x O x Sc	20	0.16532	1.01
Error (P)	515	0.16435	
M x P	20	1.23021	9.02**
M x P x O	20	0.11177	0.82
M x P x Sc	80	0.16218	1.19
M x P x O x Sc	80	0.14297	1.05
Error (MP)	2060	0.13634	

*$p < 0.05$

**$p < 0.001$